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Preparation and Evaluation of Herbal Gel Containing Multiple Plant Extracts for Acne Treatment

Versha Sharma[1,*], Poonam Kumari[2], Kavita Kashyap[2]

Abstract

A persistent inflammatory condition affecting the pilosebaceous unit, acne is caused by an increase in sebum production by sebaceous glands and an incorrect desquamation of hair follicles in response to rising testosterone levels throughout teenage years. Follicular obstruction results in follicular distention, which frequently triggers an inflammatory reaction and the growth of the Propionibacterium acnes bacteria. This project mainly focused on the formulation of an herbal gels for acne. These days, herbal gels are widely used because they're considered safe and free from side effects. The market for herbal drugs id growing day by day. This study focuses on creating and assessing a new poly-herbal anti acne formulation that includes neem leaf (Azadirachta indica) hydro-alcoholic extract, turmeric powder extract, and Aloe vera extract. We suggest using neem (Azadirachta indica) leaf hydroalcoholic extract, Curcuma longa powder extract, and Aloe vera extract, even though there are many anti-acne herbal formulations on the market. In this literature, many strong properties of plants, like antibacterial, antioxidant, and anti-inflammatory, have been documented. The gelling ingredient carbopol 940 was used in different concentrations to prepare different formulation batches. Prepared formulas were assessed. The marketed preparation and the optimized formulation were evaluated. The attempt to create an herbal gel from neem leaf (Azadirachta indica) hydro-alcoholic extract, turmeric powder, and Aloe vera extract is excellent. The gels had anti-acne properties and were non-irritating, according to the results. When tested against a standard, the efficacy was nearly identical to that of the polyherbal gel, concluded that the extract from this study demonstrated stability and was thought to be a useful herbal remedy for treating acne.

Keywords: Poly-herbal anti-acne formulation, Neem (*Azadirachta indica*), turmeric powder (*Curcuma longa*), *Aloe vera* extract, gel

INTRODUCTION

A skin condition known as acne vulgaris is so widespread that almost everyone will have it at some point in their lives. Acne is most common in teenagers, but it also affects a significant portion of men and women in their 20s and 30s. It is triggered by chemicals brought around by the female and male adrenal glands. Most commonly, it is seen on the back, chest, and face [1].

When the oily organs linked to the pores responsible for transferring dead cells to the skin's surface are blocked, acne may result. Usually, this blockage leads to bacterial colonization and an attack on the sebum, which causes whiteheads and blackheads before the body's defense mechanisms attempt to fight back and cause inflammation and scars. Using sebaceous fatty molecules into unsaturated lipids that attract neutrophils,

***Author for Correspondence**
Versha Sharma
E-mail: sharmaversha1997@gmail.com

[1]Assistant Professor, Department of Pharmacy, Himachal Pharmacy College, Nalagarh, Himachal Pradesh, India
[2]Student, Department of Pharmacy, Himachal Pharmacy College, Nalagarh, Himachal Pradesh, India

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Propionibacterium acne and Staphylococcus epidermidis play important roles in inflammatory acne and shallow illness. There are various ways to treat acne. Your age, the kind and severity of your acne, and other factors determine which treatment is best for you. To treat your skin, a healthcare professional may advise employing medicated treatments, topical drugs, or oral medications. The purpose of acne treatment is to repair the existing wounds and prevent new ones from appearing. Acne vulgaris can be treated by various gels available on the market. Acne gels are antibiotics that fight bacteria. This medicine treats acne by attacking the bacteria [2].

Gels are semisolid systems where solvated macromolecules of the dispersed phase, or any interlacing three-dimensional network of particles restrict the movement of the dispersion medium. Gel formulations can increase the duration of drug residence on the skin, hence improving bioavailability. Gel delivery systems have several benefits, including improved drug release and dispersion, ease of administration, non-greasy texture, patient compliance, and long skin residence time. Gel dosage forms have been employed recently in several pharmaceutical applications, including drug delivery for topical application of solid lipid nanoparticles, liposomal gel for vaginal delivery, and periodontal pocket and ocular administration.

The benefits of medicinal plants include widespread acceptance and patient tolerability. They are also known to contain minerals and nutrients that strengthen the skin generally. 5.3% of all skin diagnoses were for acne, with acne vulgaris being the second most prevalent type by gender. There are only a few acne treatments available because most people purchase over-the-counter acne treatments, especially topical skincare drugs, and have their acne treated at their local pharmacy. Further information about acne is, therefore, required. Allopathic medicines, which are costly when the full cost of treatment is taken into consideration and are also known to cause bacterial resistance, are gradually being replaced by alternative methods of treating acne. To improve their self-esteem, acne sufferers seek out quick fixes. With an outstanding synergistic impact against other microbial strains, the aim of this work is to create and assess an active anti-acne gel against bacteria, such as *P. aeruginosa* and *Staph. Epidermidis* [3].

CAUSES OF ACNE

The pores in human skin are connected to the oil glands beneath the skin. The pores and glands are connected by follicles. Follicles are tiny sacs that produce and discharge fluids (Figure 1).

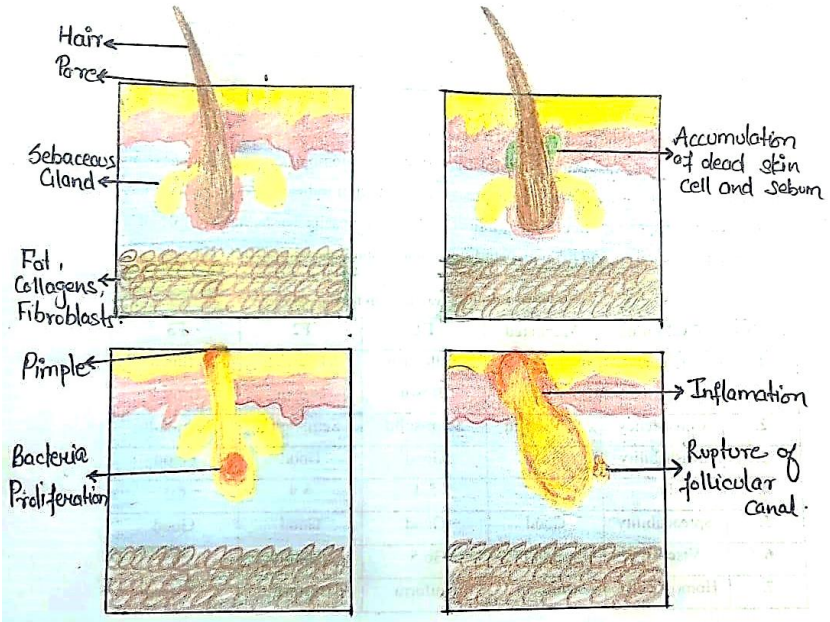

Figure 1. Occurrence of Acne.

Glands present in the skin secrete an oily liquid, i.e., Sebum. Sebum carries dead skin cells and travels through the follicles to the skin's surface. Through follicles hair grows from the skin. A pimple develops because sebum collects beneath the skin and follicles get stuck (Figure 1) [4].

A clog is formed by a togethering of hair, sebum, and skin cells. Due to bacterial contamination, it swells. Pimples arrive due to the degradation of this clog. The bacteria that reside on the skin and are responsible for acne is known as Propionibacterium acne (P. acne). Not every bacterium causes acne [5].

CERTAIN THINGS MAY TRIGGER OR WORSEN ACNE

Hormonal Changes

Hormonal changes brought on by puberty menstruation cycles are a contributing factor to acne vulgaris. The sex hormone that rises throughout puberty is called androgen. The follicular glands produce more sebum during pregnancy. Adult females who use anabolic steroids may also develop acne vulgaris [6].

- Higher sebum production.
- The pilosebaceous ducts become hyper cornified.
- Excessive bacterial activity (microbial invasion).
- Inflammation production.

Genetic Contribution

Acne may have a genetic component in certain individuals; this is seen in studies involving twins and first-degree relatives. The genetic code, SNPs in CYP1A1, TNF-alpha, and IL-1alpha have been linked to acne.

Infectious Contribution

One of the causes of acne is microorganisms, specifically Staphylococcus aureus and Propionibacterium acne. They can adjust to the unusual oil acne pore development, irritation, and insufficient sloughing.

Dietary Involvement

Foods, like chocolate, salt, and milk, that have a high glycemic index have been linked to acne vulgaris. Research has additionally demonstrated the relationship between acne and fat.

DIFFERENT TYPES OF ACNE

- *Acne Vulgaris:* Common acne is medically known as acne vulgaris. the appearance of pimples on the skin, including whiteheads and blackheads. Acne vulgaris mostly arrives at the face, chest, shoulders, and back. Over the counter drugs are available for the treatment of acne and in severe cases medical consultation is needed [7].
- *Papules:* Small red or pink pimples on the skin that occur when comedowns become inflamed. The touch may cause this kind of acne to become sensitive. Scarring may result from picking or squeezing, which can exacerbate the inflammation. Many papules may be an indication of moderate to severe acne.
- *Whiteheads:* Whiteheads are comedowns that remain closed at the skin's surface. This occurs when a clogged hair follicle is prevented from opening by oil and skin cells. Whiteheads can be effectively treated with many of the same over-the-counter medications that treat blackheads.
- *Blackheads:* Comedowns that are visible at the skin's surface are known as blackheads. They are clogged with dead skin cells and extra oil. The reason the comedowns turn black is not dirt. The sporadic light reflection from obstructed hair follicles causes blackheads. Medications that are available over the counter are often used to treat blackheads.
- *Nodules:* Big, swollen lumps that are firm to the touch are called nodules. They frequently hurt and form deep beneath the skin. Since nodules can leave scars, they should be treated by a dermatologist.

Prescription medications can be useful in treating them, but over-the-counter remedies might not be strong enough.

- *Pustules:* These represent an additional type of inflammatory acne. Their crimson ring surrounding the bumps makes them look like whiteheads. Pus, usually white or yellow, is inside the lumps. Do not squeeze or pick at pimples. Picking the skin might result in the development of black patches or scars.
- *Cyst:* Skin cysts are not uncommon. They may appear around an object that appears in the skin or when acne clogs a sebaceous gland. Although benign and not cancerous, these cysts can cause pain and cosmetic changes. They can get infected and require medical attention because of the pain and swelling (Figure 2).

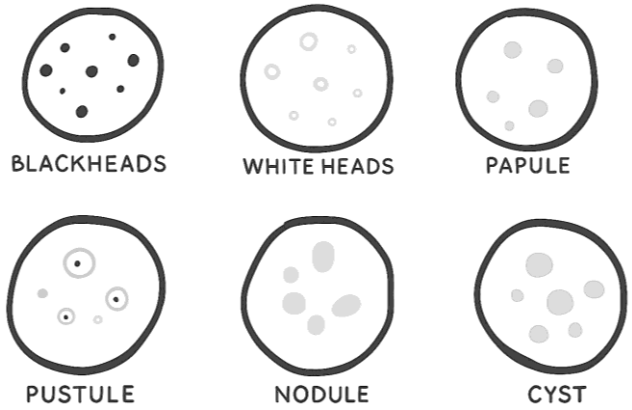

Figure 2. Types of Acne.

REVIEW OF LITERATURE

- *Sawarkar H.A. et al. (2010) [8]:* The development and biological evaluation of herbal anti-acne gel by H.A. Sawarkar, S.S. Khadabadi, D.M. Mankar, I.A. Farooqui, and N.S. Jagtap likely involves creating a topical gel formulation using herbal ingredients specifically targeted at treating acne. The biological evaluation aspect likely entails testing the efficacy of the gel on acne-prone skin, possibly through in vitro and/or in vivo studies to assess its antimicrobial, anti-inflammatory, and skin-compatibility properties. This research could contribute to the development of natural and potentially effective treatments for acne, which is a common skin condition affecting many individuals [8].
- *Yamini K. et al. (2013) [9]:* The preparation and evaluation of herbal anti-acne gel by K. Yamini and T. Onesimus likely involve researcher**s** [10, 11]: Manish Kamble, Tejaswini Selwate, Ashwini Ingole, Disha Dhabarde, and Jagdish Baheti formulated and evaluated an anti-acne face wash gel utilizing guava seed extract. This presumably involved making a gel-based cleanser that included guava seed extract, which is known to have anti-acne properties. The evaluation process may include testing the face wash gel for its effectiveness in cleansing the skin, reducing acne breakouts, and improving overall skin health. This research aims to provide a natural and potentially effective solution for managing acne-prone skin.
- *Yadav S. et al. (2019) [12–14]:* The formulation and evaluation of an anti-acne herbal face wash gel by Samiksha Yadav and Mansi Gupta likely involves creating a gel-based cleanser using herbal ingredients known for their acne-fighting properties. The evaluation process may include testing the face wash gel for its ability to effectively cleanse the skin, reduce acne breakouts, and soothe irritation. This research aims to develop a gentle yet effective solution for managing acne-prone skin using natural herbal extracts.
- *Biyyala S. et al. (2022) [15–17]:* The formulation and evaluation of an anti-acne herbal gel by Susmitha Biyyala and Teja Nayudu likely involves developing a gel-based product using herbal ingredients known for their acne-fighting properties. The goal of this research is to use the advantages of herbal extracts to offer a natural and possibly efficient remedy for acne.

AIM AND OBJECTIVE

Aim

To develop a Polyherbal Anti-Acne Gel which can be used to treat acne, and which can also give various objectives like moisturizer, remove scars, non-irritant.

Objective

- To set a formula for polyherbal Acne–Acne gel by using different extracts of different herbs.
- To develop a novel dosage form of different herbs for the effective treatment of acne.
- To formulate a formulation with easily available ingredients and which give less side effects.

Plan of Work

- Literature survey.
- Selection of Herbs.
- Procurement of dried powder of *Curcuma longa* and leaves of *Azadirachta indica*.
- Extraction and collection of the hydroalcoholic extract of Neem and Turmeric by the process of Maceration.
- Preliminary phytochemical screening.
- Selection of solvents and the gelling agent.
- Trial Formulation of Anti-Acne gel.
- Evaluation.
- Result and Discussion.
- Conclusion.

MATERIALS AND METHODS

Materials

Azadirachta Indica

Taxonomical Classification

- *Common Name:* Neem, Nimtree, Margosa.
- *Kingdom:* Plantae.
- *Division:* Magnoliophyte.
- *Class:* Magnoliopsida.
- *Order:* Sapindales.
- *Family:* Meliaceace.
- *Genus:* Azadirachta.
- *Species: Azadirachta indica*.
- *Scientific Name: Azadirachta indica* [18].

Chemical Constituents

Indica L. (NEEM) shows a therapeutic role in health management due to rich source of various types of ingredients. The most important active constituents are azadiracta and the others are nimbolinin, nimbin, nimbidin, nimbidol, sodium nimbinate,gedunin, salanin, and quercetin. Ingredients found in leaves include nimbin, nimbanene, 6-desacetylnimbinene, amino acid, n-hexacosanol, nimbolide, nimbandiol, and ascorbic acid nimbiolquercetion, beta-sitostreol, 7-desacetyi-7-benzoylazadiradione, 7-desacety-l7-benzoylgedunin, 17-hydroxyazadiradione, and purified from fresh neem leaves, polyphenolic flavonoids have been shown to possess antimicrobial and antifungal characteristics. The seeds of the plant also contain important components, such as azadirachtin and gedunin (Figures 3 and 4) [19].

Uses

Neem is known as a good substance for everything. It is known for its medical as well as its cosmetic uses. Every part of the neem is useful and can be used. Neem has various properties like antibacterial, antifungal. It is also used in the formulation of shampoos, soaps and creams. Neem is good for skin health and can treat skin diseases like pimple. Neem is also good for oral health [20, 21].

Figure 3. Neem leaves.

Figure 4. Neem powder.

There are many evidence that neem is traditionally used for the treatment of diabetes and regulate blood sugar levels.

Curcuma longa

Taxonomical Classification

- *Kingdom:* Plantae.
- *Division:* Leave sheath, Leaf.
- *Class:* Monocotyledon.
- *Order:* Zingiberales.
- *Family:* Zingiberaceae.
- *Genus:* Curcuma.
- *Species:* C. longa.
- *Scientific Name: Curcuma longa*.
- *Common Name:* Turmeric, Saffron Indian [22].

Chemical Constituents

Curcumin demethoxycurcumin, bisdemetho xycurcumin, eugenol, dihydrocurcumin, azulene, borneol, d-camphene, caorylicacid, cineol, and turmerone (Figure 5) [23, 24].

Uses

Turmeric has been shown to have antimicrobial, antibacterial, and anti-neoplastic (anticancer) qualities in addition to its well-known anti-inflammatory and antioxidant qualities. Particularly, the curcuminoids found in turmeric have the ability to successfully combat the underlying factors that cause inflammation in the skin, which can include germs or oil accumulation on the skin's surface [24]. In addition to leaving the skin more susceptible to UV radiation, environmental stressors, bacterial, fungal,

and parasite invasion, chronic acne also results in scarring of the skin. Turmeric can assist your skin, which is still healing, strengthens its defences against future breakouts of acne [25].

Figure 5. Turmeric Powder.

Aloe vera

Taxonomical Classification

- *Kingdom:* Plantae.
- *Class:* Monocotyledon.
- *Order:* Asparagales.
- *Family:* Asphodelaceae.
- *Genus:* A. Vera.
- *Species: Aloe vera*.
- *Scientific Name: Aloe vera*, Aloe barbadensis.
- *Common Name:* True aloe, Indian Aloe [26].

Active Components with Their Properties

A. vera contains 75 potentially active constituents: amino acids, carbohydrates, lignin, saponins, minerals, enzymes, vitamins, and salicylic acids. Vitamins: It contains Vitamins A (beta-carotene), C, and E, which are antioxidants (Figure 6) [27].

Figure 6. *Aloe vera* chemical constituents.

Uses

The anti-inflammatory qualities of Aloe vera are a solid rationale for its widespread usage in treating skin conditions. Thus, Aloe vera may aid in the reduction of edema. *Aloe vera* can be applied to a red, swollen pimple to assist lessen discomfort and tenderness [28]. *Aloe vera* can cure wounds, which means that it might help open acne scars. *Aloe vera* gel or an aloe-containing moisturizer can be especially beneficial if your skin is feeling dry and sensitive after treating your acne (Table 1) [29].

Table 1. List of materials with its properties.

S.N.	Materials	Properties
1.	Neem Extract	Anti-inflammatory, Anti-fungal, Anti-bacterial, oxidant, Anti-aging.
2.	Turmeric Extract	Helps brighten dark spots, heal skin wounds, moisturizes dry skin, Antiaging, fade skin scars.
3.	*Aloe vera* Extract	Managing Acne, soothing skin conditions, moisturizing skin, eliminates dead skin cells, remove dark circles.
4.	Carbopol 940	Gelling agent.
5.	Methyl Paraben	Preservative.
6.	Propyl Paraben	Preservative.
7.	Glycerine	Humectant.
8.	Triethanolamine	Neutralizer.
9.	Ethanol	Solvent.
10.	Rose Oil	Perfume.

Methods

Extraction of Azadirachta indica

- *Collection: Azadirachta indica* leaves were collected from Himachal Pharmacy College campus, Maganpura situated in state Himachal Pradesh. Wash the collected leaves and shade dry in room temperature for 5 to 6 days. Then dried leaves of neem were grinded in a grinder to reduce its size and pass through sieves no. 20 and 40 to obtain fine powder. Finally, neem powder was stored in an airtight container [30].
- *Extraction Process:* Extraction process was performed by using Soxhlet apparatus. Using Hydro alcoholic solution 20g powder of neem was constantly extracted for 48 hours. The extract was filtered and then collected. The hydroalcoholic extract of neem was stored in an airtight container (Figure 7).

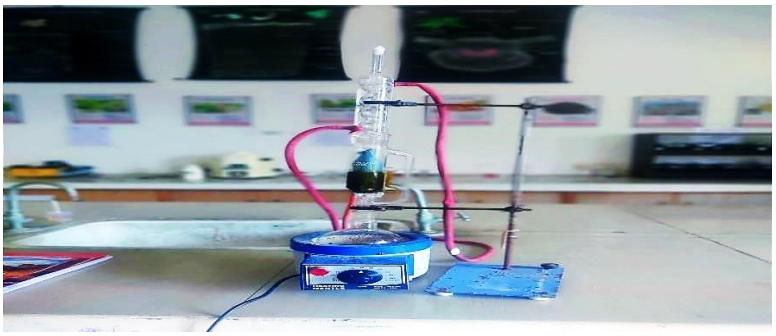

Figure 7. Extraction of neem.

Extraction of Curcuma longa

- *Collection:* The power of *Curcuma longa* was purchased from the local market. Powder was passed through sieves to obtain a uniform powder. Then the powder of turmeric was stored in a container [31].
- *Extraction Process:* In a conical flask, 20 g of turmeric powder was added in 50 ml of distilled water and then kept aside for 48 hrs. Then the product was filtered and stored in an airtight container (Figure 8).

Figure 8. Extraction of *Curcuma longa*.

Extraction of Aloe vera

- *Aloe vera* leaves collected from the college campus. Wash the *Aloe vera* leaves with water and peel off the outer skin of it. Then make a slurry by using a mortar and pestle. The slurry was filtered, and the extract was stored (Figure 9) [32].

Figure 9. Extraction of *Aloe vera*.

Preparation of Polyherbal Gel

- Take 100 ml hot purified water and disperse in it and stir continuously and then place it aside for overnight to swell. The Carbopol 940 will form gel form.
- Take methyl paraben and propyl paraben and dissolve it in 5ml of distilled water by heating on water bath. Let it cool then add 10ml glycerin to it. Add 2 ml of each extract which was prepared previously.
- Take Carbopol 940 gel and add above mixture to it with continuous stirring. Add Triethanolamine dropwise to gel to adjust its pH to skin pH.
- For fragrance add few drops of rose oil for fragrance.
- The final formulation was transferred into an airtight container and labelled (Table 2, Figure 10).

Table 2. Formulation of polyherbal gel.

S.N.	Ingredients	Quantities
1.	Extracts	2 ml
2.	Carbopol 940	2 g
3.	Methyl Paraben	0.2 g
4.	Propyl Paraben	0.1
5.	Glycerin	10 ml
6.	Triethanolamine	q.s.
7.	Ethanol	50 ml
8.	Rose Oil	q.s.

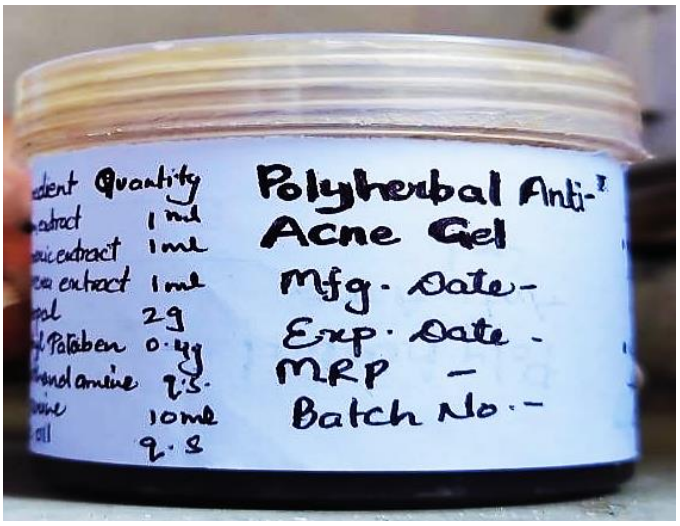

Figure 10. Polyherbal anti-acne gel.

EVALUATION PARAMETERS OF GEL FORMULATION

Physical Evaluation

Physical parameters, such as color, appearance, consistency and homogeneity were checked [33–35].

- *Color:* Against the white background the color of the Formulation was checked out.
- *Consistency:* By applying on skin.
- *Greasiness:* By the application on to the skin.
- *Odor:* Mix the gel in water and check its odor.

Determination of pH

Digital pH meter is used to check the pH of formulation. Take 100 ml water and dissolve 1 gram of gel to it and keep aside for 1 hour. Take Three separate measurements to determine the pH of Formulation. Make sure that the instrument is calibrated with standard buffer solution Before to use.

Washability

After applying formulations to the skin, the manual examination determined the degree of ease and effectiveness of water washing.

Spreadability

Spreadability The term “spreadability” refers to the amount of space that gel easily distributes when applied to skin or other affected areas. A formulation’s spreading value has an impact on its medicinal efficacy as well.

To ensure the sample had a consistent thickness, 10g of weight was placed on top of a glass slide for five minutes after a 2g sample was placed between two glass slides. The time taken to separate the two slides was measured to assess how easily the sample could spread [36].

RESULTS AND DISCUSSION

Preformulation Study

Dark green, yellow and white are the observed color of *Azadirachta indica* extract, *Curcuma longa* extract and *Aloe vera* extract, respectively. The phytochemical analysis of extracts was done tested like alkaloids, tannins, flavonoids, carbohydrates, phytosteriods, terpenoids, anthraquinone glycosides and saponins. The phytochemical analysis and pH of the various extracts results are shown in Table 3 [37].

Physicochemical Evaluation of Gel Formulation

The gel was checked by eye to see its color, thickness, smoothness, and how it looked overall. The inspection showed that the gel had no lumps, a uniform color, and was free of any fibers or particles. It

was also easy to wash off. Additionally, the pH of all the formulations was close to the skin's natural pH, with good spreadability and viscosity (Table 4) [38].

Table 3. Phytochemical screening of extracts.

S.N.	Evaluation	Marketed	Observation
1.	Colour	Green	Yellowish Brown
2.	Consistency	Semi-solid	Semi-solid
3.	Washability	Good	Good
4.	Ph	5.8	5.4
5.	Spreadability	5.9	5.2
6.	Viscosity	33.5	36.5
7.	Homogeneity	Uniform	Uniform

Table 4. Physicochemical evaluation of formulations.

S. N.	Phytoconstituents	*Azadirachta indica*	*Curcuma longa*
1.	Alkaloids	+	+
2.	Saponin Glycosides	+	+
3.	Tannins	+	+
4.	Terpenoids	–	–
5.	Flavonoids	+	+
6.	Amino Acids	+	+

CONCLUSIONS

The demand for herbal products is increasing worldwide. Creating a herbal face wash with natural ingredients like neem leaves, turmeric, and *Aloe vera* is a promising and effective idea. These plants are known for their antimicrobial, anti-inflammatory, refreshing, cleansing, dirt-absorbing, and antioxidant properties. The formulations, made with varying concentrations of these extracts, were evaluated for several parameters, including color, appearance, consistency, washability, pH, spread ability, extrudability, and skin irritation. The evaluation results showed that both the herbal face wash and the marketed formulation performed similarly, with no side effects or skin irritation observed in either product.

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